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OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
CODE OOCC3
ARLINGTON VA 22217-5660

Navy Case No. 73994

FLEXIBLE FERRITE LOADED LOOP ANTENNA ASSEMBLY

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

(1) Field Of The Invention

This invention relates to a flexible ferrite loaded loop antenna assembly and more particularly, to a flexible antenna assembly that will permit VLF/LF reception in the athwart direction (side to side) relative to its deployment along a cable.

(2) Description of the Prior Art

Three types of antennas have been used by submarines for reception of radio signals in the very low frequency and low frequency (VLF/LF) transmission bands. The first is a mast mounted antenna which is omni-directional and extends above the ocean surface. Such an antenna is used when the submarine is not concerned with being detected. The second, a voltage probe antenna exists in the periscope and extends above the ocean surface. The third, a buoyant cable antenna, is used when the submarine is submerged and must avoid detection.

The buoyant cable antenna floats on the ocean surface and is deployed along with a buoyant cable. The buoyant cable antenna must be flexible because it is launched through a transfer mechanism which bends the cable through a six inch radius. Because flexibility is required, buoyant cable antennas have employed a horizontal wire antenna element which can receive only in the fore and aft (front and back) direction relative to its deployment. This limits the reception capability of the buoyant cable antenna.

Accordingly, there is a need for a buoyant cable antenna system with omni-directional capability that can be launched under all sea conditions at depth without danger of being detected. To achieve omni-directionality, such a buoyant cable antenna system requires the addition of a loop antenna that can receive VLF/LF in athwart direction relative to ship's heading. A buoyant cable mounted loop antenna must be capable of being bent through at least a six inch radius during deployment, and pass signals received on the wire antenna. Therefore, what is required is a buoyant cable antenna system including a flexible loop antenna which will provide the desired omni-directional signal reception and is compatible with existing deployment mechanisms.

SUMMARY OF THE INVENTION

This invention features a loop antenna deployable along a cable. The loop antenna has a core region comprising a plurality of cylindrical or annular ferrite beads. The annular shaped ferrite beads include a center hole and a generally concave first end and a generally convex second end, with a coaxial cable passing through the center hole. The ferrite beads are aligned with the concave end of one bead against the convex end of another bead. This allows the cable to flex while the beads maintain contact with each other. The ferrite beads of the core region are spring loaded to keep the ferrite beads in contact with each other, yet allowing the cable to bend and flex without harm during deployment.

The core region including the plurality of ferrite beads includes a loop wire element wrapped helically around it, forming the loop antenna. The loop wire element starts and ends at the same end of the core region.

This novel loop antenna can be combined with a straight wire antenna to provide an omni-directional cable antenna assembly. The straight wire antenna receives signals in the fore-aft (front to back) direction, while the loop antenna receives signals in the athwart (side to side) direction. The signal from the straight wire antenna is amplified by an amplifier, and then passes on the coaxial cable through the center of the loop antenna core region. The loop antenna signal is amplified by a second amplifier, then travels by twisted pair parallel with the coaxial cable, through a transmission cable back to the vessel.

In the preferred embodiment, the entire cable is buoyant to float on the surface of the ocean, and is sufficiently flexible to bend around a 6 inch radius during deployment. A submarine can therefore remain undetected underwater, yet receive radio transmissions on an omni-directional antenna.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention and many of the attendant advantages thereto will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic view of the deployable antenna cable assembly according to the present invention;

FIG. 2 is a sectional view of the athwart loop antenna portion of the deployable antenna assembly according to the present invention;

FIG. 3 is a sectional view of the core segments that form part of the present athwart loop antenna;

FIG. 4 is a sectional view of the athwart loop antenna encased in polyethylene; and

FIG. 5 is a schematic of the major elements that make up the deployable antenna cable assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENT

An omni-directional, buoyant, deployable cable antenna, assembly 10, FIG. 1, according to the present invention is deployable from a vessel such as submarine 12. Buoyant cable 10 is intended for use in the Navy buoyant cable antenna assembly used on submarines to receive VLF/LF (very low frequency/low frequency) signals. Buoyant cable 10 is deployed while the submarine is submerged, through the buoyant cable transfer mechanism 14 and it floats on the surface of the ocean 16, to allow reception of radio signals while avoiding detection of submarine 12 by sea or air vessels.

The present invention combines a standard prior art horizontal wire antenna element 18 which can receive radio transmissions in the fore and aft (front and back) direction as designated generally by arrow 19. Horizontal wire antenna element 18 is connected to amplifier 20 which boosts the signal from wire antenna element 18. The athwart loop antenna 22 provides reception in the athwart ship (side to side) direction as designated generally by arrow 21. The signal from loop antenna 22 is boosted by another amplifier 23. Both loop antenna 22 and horizontal wire antenna 18 are connected to a buoyant cable transmission line 26 which connects to submarine or other vessel 12. This allows the antenna assembly 10 to receive transmissions omni-directionally.

When the cable antenna assembly 10 is deployed, it is bent through a radius of 6 inches by transfer mechanism 14. Coaxial cable 27 FIG. 2, passes through the center of the loop antenna and carries the signal from the horizontal wire antenna amplifier to the ship or submarine. Surrounding coaxial cable 27 are ferrite beads 24 which form the center core of the loop antenna 22 and allow the athwart loop antenna to bend through a 6 inch radius. The ferrite beads are held captive proximate at least a first end 29 by fixed end retainer 28 which is secured to coaxial cable 27 by set screw 30. At the second end 31 of the loop antenna is fixed spring retainer 36 also secured to coaxial cable 27 by a set screw 38. Compression spring 34 is located between fixed spring retainer 36 and flexible spring retainer 32 which is proximate the ferrite beads 24. Compression spring 34 maintains the ferrite beads 24 under minimum pressure to keep the beads in contact with each other and maintain the antenna core conductance. As athwart loop antenna 22 flexes, the beads 24 will maintain contact with each other while spring 34 is further compressed. This allows flexibility and crush resistance during deployment and use of the athwart loop antenna.

Each ferrite bead such as ferrite bead 24a of FIG. 3 is machined to be generally cylindrical or annular in shape and including exterior region 46, concave end 40 and convex end 42. Typical dimensions of each ferrite head such as 24 are .39" in diameter, and .5" long with .195" concave and convex regions.

Hole 44 through the center of the ferrite bead 24 allows coaxial cable 27 to pass through ferrite beads. The concave tapering of end 40, and convex tapering of end 42 allow adjacent ferrite bead such as ferrite beads 24b and 24c to maintain substantial contact with each other when the cable assembly is flexed. This ensures the ferrite beads will maintain good electrical contact as the cable flexes.

Ferrite beads 24 are surrounded by a polyethylene tube 54 as shown in FIG. 4. Polyethylene tube 54 is etched to allow a copper wire 56 (litz wire) forming the loop antenna to be wrapped around polyethylene tube 54. The etching scribes an evenly spaced helix from start to finish and return, and allows litz wire 56 to form a helix that begins and ends at point 59 in athwart loop antenna 22, forming the loop antenna. The doubling back of the loop antenna winding helps to cancel out any signal noise from the coaxial cable passing through the center of the ferrite beads 50 not mentioned.

The signal from litz wire loop 56 is carried by twisted pair wires 60, while the signal from the horizontal wire loop amplifier is carried by coaxial cable 27. Twisted pair wire 60 carry the signal from the athwart loop antenna amplifier. Loop antenna assembly is coated with foamed polyethylene with glass balloons 58 to provide water protection and buoyancy for the cable assembly.

Horizontal wire antenna element 18, FIG. 5 is comprised of 100 feet of wire which provides an effective height of 15 millimeters at 20 kilohertz. Horizontal wire antenna element 18 is grounded at cable termination point 61, and feeds the signal into a standard type of wire antenna amplifier 20. Wire antenna amplifier 20 provides 32 decibel gain within the range of 10 to 200 kilohertz. Wire antenna amplifier 20 provides an amplified signal on coaxial cable 27.

Loop antenna 22 provides a signal on twisted pair lines 60 to a loop antenna amplifier 24. Loop antenna amplifier 24 provides 50 decibel gain at 20 kilohertz (kHz). The signals carried on coaxial cable 27 and twisted pair 62 pass through buoyant cable transmission line 26.

The novel, omni-directional cable antenna as disclosed achieves omni-directionality by combining a standard wire antenna element with a unique loop antenna element which can bend and flex during deployment and use. This allows submarines to remain submerged and undetected when they need to receive VLF/LF radio messages. The cable antenna can be deployed and retracted underwater, yet provides the omni-directionality of a mast-mounted antenna which can only be used on the surface.

Many modifications of the presently disclosed invention will become apparent to those of skill in the art

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FLEXIBLE FERRITE LOADED LOOP ANTENNA ASSEMBLY

ABSTRACT OF THE DISCLOSURE

A buoyant loop antenna, deployable along a cable, includes a core region comprising a plurality of annular ferrite beads. These annular shaped beads include a center hole and generally concave first end and a generally convex second end. The ferrite beads are aligned with the concave end of one bead against the convex end of another bead. This allows the cable to flex while the beads maintain contact with each other, providing flexibility and resistance to crushing. The core region has a loop wire wrapped helically around it, forming the loop antenna. The loop wire element starts and ends at the same end of the core region, forming a loop. This loop allows transmission and reception in and athwart (side to side) direction. This novel wire loop antenna can be combined with a straight wire antenna (which provides reception in a fore and aft direction) to provide an omni-directional cable antenna assembly.

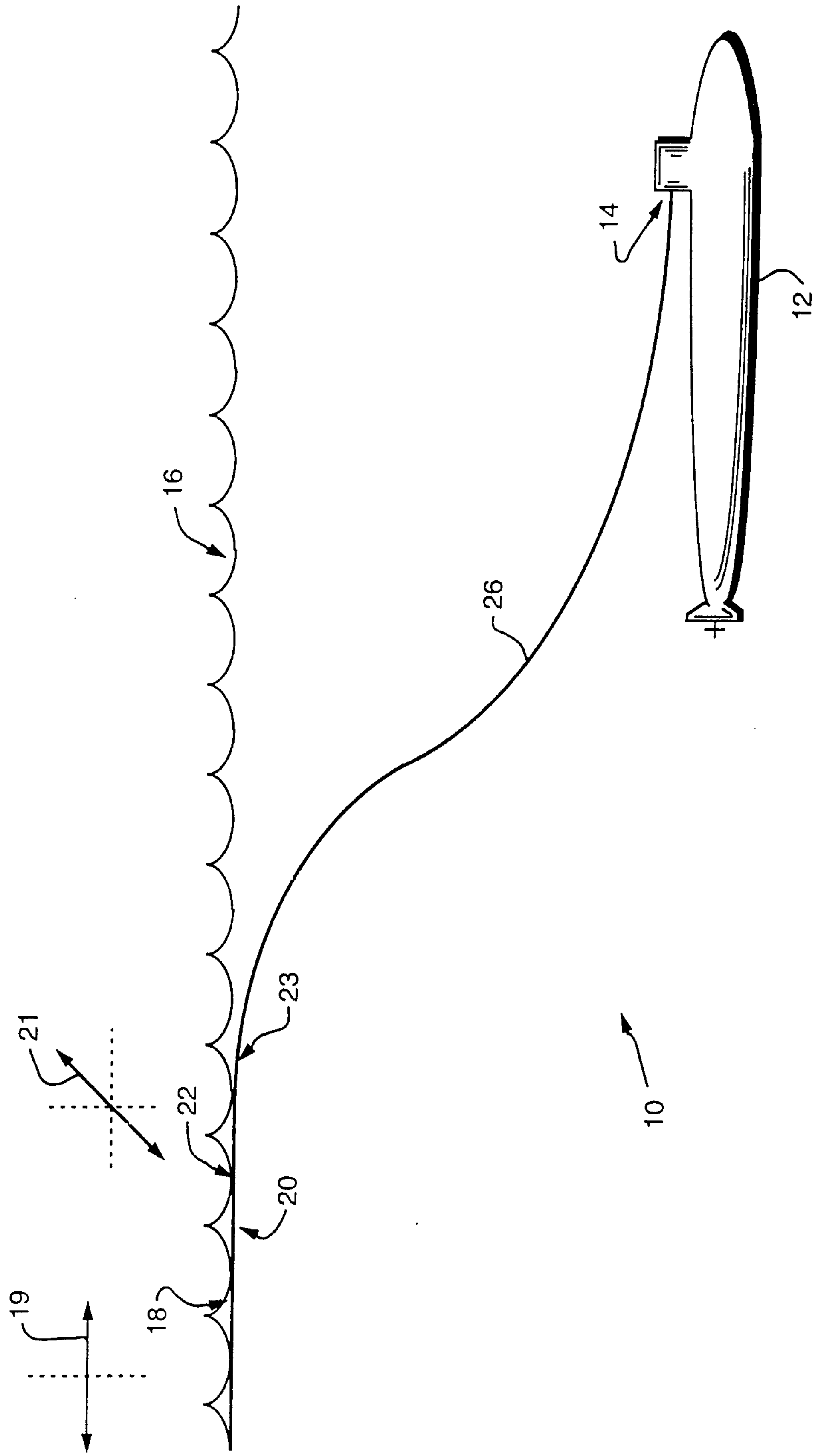

FIG. 1

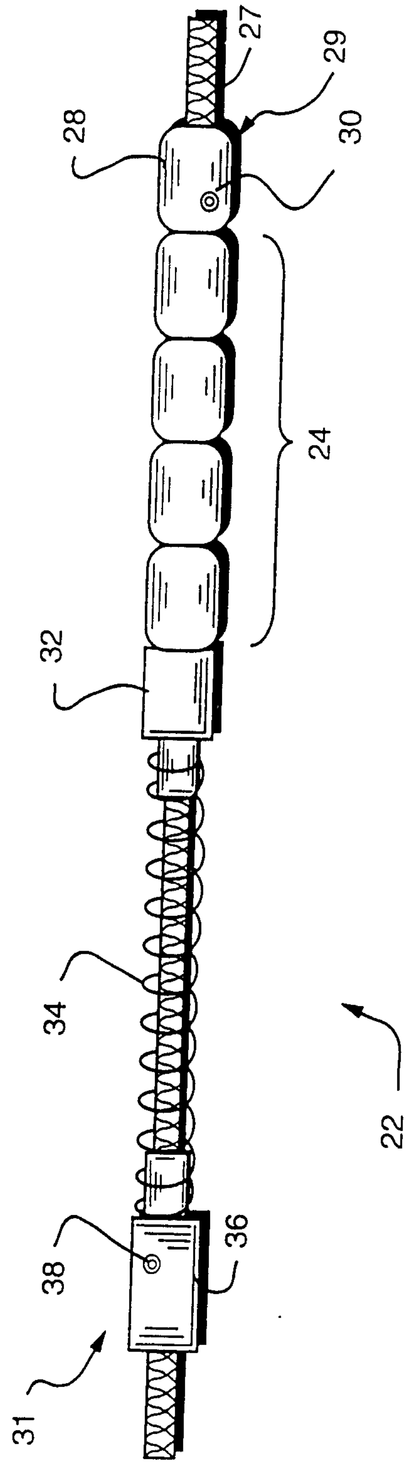

FIG. 2

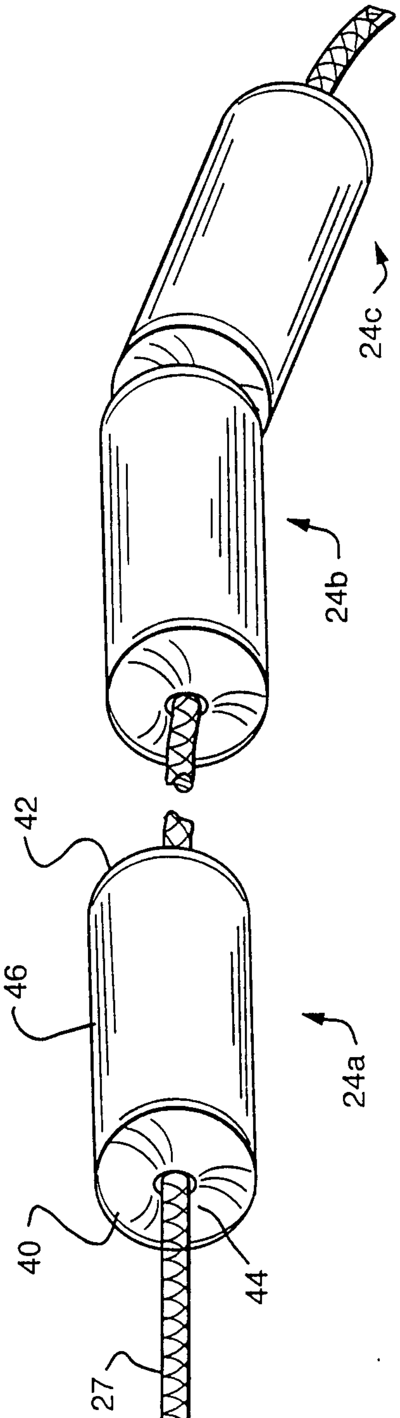

FIG. 3

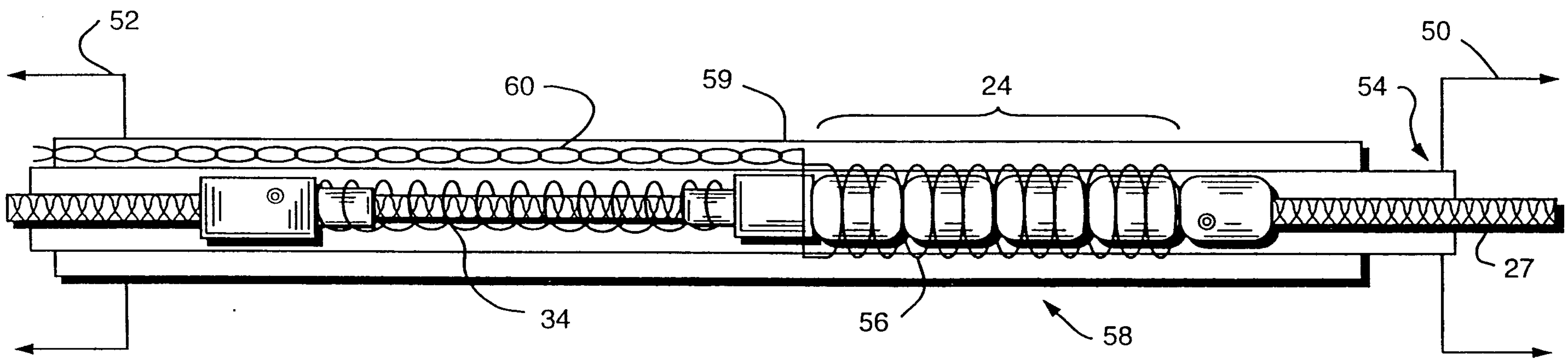

FIG. 4

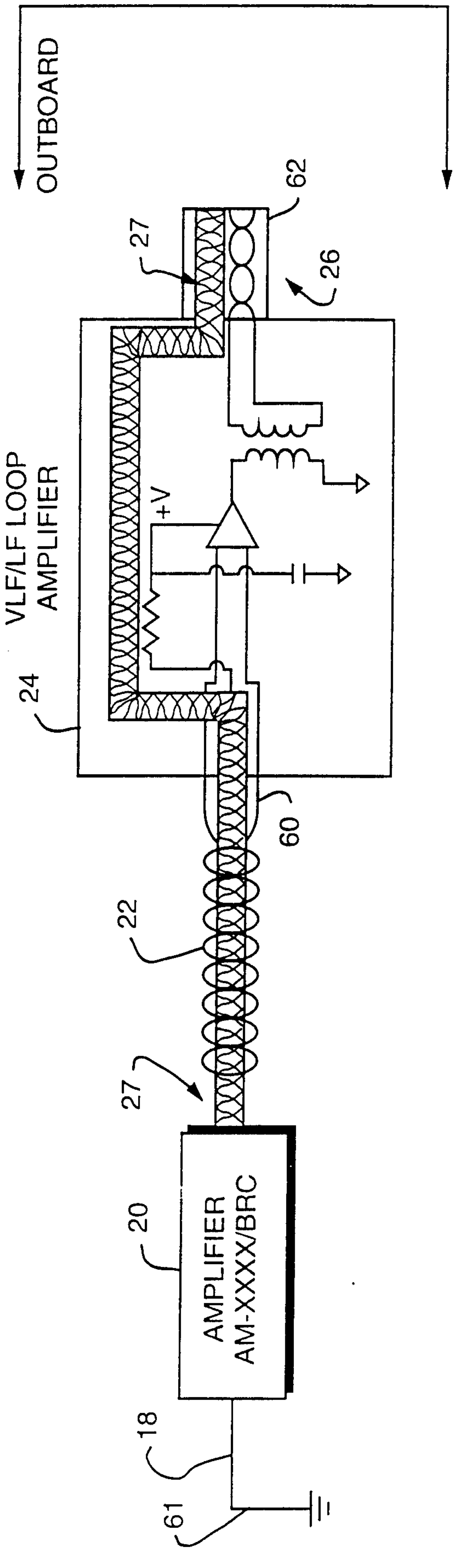
OUTBOARD
62
27
26
VLF/LF LOOP
AMPLIFIER
+V
24
60
22
27
20
AMPLIFIER
AM-XXXX/BRC
18
61

FIG. 5